Supplementary Material

Table S1 | Amazon Vegetation Sites. Approximate location and elevation of the 130 sites within the Amazon biome used in the study.

Country	Site code	Site Name	Elevation	Latitude	Longitude
Bolivia	Bolivia-CRP	Cerro Pelao	350	-14.54	-61.50
Bolivia	Bolivia-LFB	Los Fierros Bosque	245	-14.58	-60.83
Bolivia	Bolivia-LSL	Las Londras	190	-14.40	-61.14
Bolivia	Bolivia-RET	Reserva El Tigre	160	-10.97	-65.72
Bolivia	Bolivia-SCT	Sacta	248	-17.09	-64.77
Brazil	Brazil-AFL	Alta Floresta	275	-9.62	-55.89
Brazil	Brazil-BDF	BDFFP project	75	-2.34	-59.85
Brazil	Brazil-CAX	Caxiuana	15	-1.74	-51.46
Brazil	Brazil-DOI	RESEX Chico Mendes: Seringal Dois Irmãos	203	-10.55	-68.31
Brazil	Brazil-FEC	Fazenda Experimental Catuaba	204	-10.07	-67.62
Brazil	Brazil-FLO	Fazenda Floresta	377	-12.81	-51.85
Brazil	Brazil-MIN	Rio das Minas, Parque Nacional da Serra do Divisor	226	-8.57	-72.90
Brazil	Brazil-MTH	Marechal Thaumaturgo, Alto Rio Juruá	246	-8.88	-72.79
Brazil	Brazil-POR	RESEX Chico Mendes: Seringal Porongaba	268	-10.80	-68.77
Brazil	Brazil-RFH	Reserva Florestal Humaita	176	-9.75	-67.67
Brazil	Brazil-RST	Reserva Extrativista do Alto Juruá	279	-9.04	-72.27
Brazil	Brazil-SIP	Fazenda Continental, Sinop	385	-11.41	-55.32
Brazil	Brazil-SMT	Fazenda Santa Marta, Ribeirão Cascalheira	332	-12.82	-51.77
Brazil	Brazil-TEC	TEAM Caxiuana	15	-1.71	-51.43
Colombia	Colombia-AGP	Amacayacu: Agua Pudre	120	-3.72	-70.30
Colombia	Colombia-LOR	Amacayacu: Lorena	94	-3.06	-69.99
Ecuador	Ecuador-BOG	Bogi	284	-0.70	-76.47
Ecuador	Ecuador-TIP	Tiputini	250	-0.63	-76.14
French Guiana	French Guiana-NOU	Nouragues Petit Plateau	127	4.09	-52.67
French Guiana	French Guiana-PAB	Paracou	40	5.27	-52.92
French Guiana	French Guiana-PAR	Guyaflux	35	5.28	-52.92
Guyana	Guyana-FMH	Forest reserve Mabura	122	5.18	-58.69
Guyana	Guyana-IWO	Iwokrama	139	4.63	-58.72
Guyana	Guyana-PIB	Pibiri	94	5.03	-58.60
Peru	Peru-AGJ	Aguajal	300	-11.89	-71.36
Peru	Peru-ALP	Allpahuayo	130	-3.95	-73.43
Peru	Peru-BAR	Barranco	345	-11.90	-71.42
Peru	Peru-CUZ	Cuzco Amazonico	190	-12.53	-69.05
Peru	Peru-JEN	Jenaro Herrera	151	-4.88	-73.63
Peru	Peru-LAS	Los Amigos	280	-12.55	-70.09
Peru	Peru-MNU	Manu	358	-11.88	-71.21
Peru	Peru-PAK	Pakitza	347	-11.94	-71.27
Peru	Peru-SUC	Sucusari	118	-3.25	-72.89

Peru	Peru-TAM	Tambopata	225	-12.83	-69.26
Peru	Peru-YAN	Yanamono	132	-3.43	-72.84
Suriname	Suriname-KAB	Kabo	58	5.26	-55.77
Venezuela	Venezuela-ELD	El Dorado	404	6.11	-61.40
Venezuela	Venezuela-RIO	Rio Grande	318	8.11	-61.69
Venezuela	Venezuela-SCR	San Carlos de Rio Negro	105	1.93	-67.04

Table S2 | Stepwise model selection. Models are ranked based on their optimal balance between explanatory power and complexity (lower AIC).

Nova Xavantina - Global model: CV of blue ~ sla : season + (1 | plot)

Model	(Intercept)	season	sla	season : sla	df	logLik	AIC	delta	weight
8.000	0.997	+	0.016	+	7	-5694.029	11402.059	0.000	1
4.000	1.751	+	0.007	NA	6	-5751.060	11514.120	112.061	4.64E-25
2.000	2.402	+	NA	NA	5	-5795.112	11600.223	198.164	9.31E-44
3.000	2.090	NA	0.007	NA	5	-5948.607	11907.215	505.156	2.03E-110
1.000	2.659	NA	NA	NA	4	-5980.436	11968.871	566.813	8.28E-124

Amazon - Global model: CV of blue ~ sla : season + esi : season + evap : season + wue : season + (1 | region) + (1 | plot)

Model	(Intercept)	esi	evapotranspiration	sla	wue	df	logLik	AIC	delta	weight
11	30.742	NA	-0.016	0.243	NA	6	-2979.864	5971.728	0.000	0.084
9	25.031	NA	NA	0.239	NA	5	-2980.881	5971.762	0.033	0.082
12	17.936	15.450	-0.017	0.238	NA	7	-2979.643	5973.286	1.558	0.038
27	30.152	NA	-0.018	0.234	2.224	7	-2979.675	5973.351	1.622	0.037

Amazon - Global model: CV of blue ~ year : season : region + (1 | plot)

Model	(Intercept)	year	region : year	season : year	region : season : year	df	logLik	AIC	delta	weight

128	56.041	-0.025	+	+	+	178	-15924.856	32205.713	0	0.999
64	14.209	-0.005	+	+	NA	135	-15974.914	32219.827	14.114	0.001
32	0.357	0.002	+	NA	NA	134	-15980.716	32229.432	23.720	7.06E-06
48	51.070	-0.023	NA	+	NA	92	-16028.632	32241.265	35.552	1.90E-08

Amazon - Global model: % Δ CV of Blue ~ region + season + region : season

Model	(Intercept)	region	season	region : season	df	logLik	AIC	delta	weight
8	-51.291	+	+	+	81	-962.080	2086.160	0.000	0.999
3	-5.418	NA	+	NA	3	-1047.411	2100.821	14.661	0.001
1	4.181	NA	NA	NA	2	-1055.185	2114.370	28.210	7.48E-07
4	-31.669	+	+	NA	44	-1020.036	2128.072	41.912	7.92E-10
2	-19.521	+	NA	NA	43	-1032.007	2150.013	63.853	1.36E-14

Amazon - Global model : % Δ CV of Blue ~ PC1 : season + PC2 : season + PC3 : season + (1 | region)

Model	(Intercept)	PC1	PC2	PC3	season	PC1 : season	PC2 : season	PC3 : season	df	logLik	AIC	delta	weight
26	-4.363	-5.018	NA	NA	+	+	NA	NA	6	-1041.095	2094.2	0	0.283
30	-4.319	-4.934	NA	-3.062	+	+	NA	NA	7	-1040.142	2094.3	0.1	0.27
94	-4.475	-4.972	NA	-4.383	+	+	NA	+	8	-1039.82	2095.6	1.45	0.137

28	-4.416	-4.942	0.5619	NA	+	+	NA	NA	7	-1041.05	2096.1	1.91	0.109

CV = Coefficient of Variation; SLA = Specific Leaf Area; ESI = Evaporative Stress Index; WUE = Water Use Efficiency; Evap = Evapotranspiration.

Table S3 | Climatic and hydrological indicators obtained from TerraClimate.

Variable	Description	Units	Relevance to Study
aet (Actual Evapotranspiration)	Monthly total amount of water evaporated from the soil and transpired by plants	mm	Influences water availability for plant growth; changes in evapotranspiration affect vegetation water requirements
def (Climate Water Deficit)	Monthly total deficit between potential evapotranspiration and actual evapotranspiration	mm	Indicates water stress conditions; negative def values suggest drier conditions impacting vegetation
PDSI (Palmer Drought Severity Index)	Palmer drought severity index at the end of the month	unitless	Reflects drought severity; negative values indicate drier conditions potentially impacting vegetation health
pet (Potential Evapotranspiration)	Monthly total maximum amount of water that could be evaporated from the soil and transpired by plants	mm	Reflects the maximum evaporative demand under current climate conditions; changes may indicate shifts in climate patterns
pr (Precipitation)	Monthly total amount of precipitation, influencing water availability for plant growth	mm	Directly impacts water supply for vegetation; changes in precipitation patterns can impact plant health
ro (Runoff)	Monthly total amount of water that flows over the land surface	mm	Changes in runoff can affect soil moisture levels, influencing vegetation health
soil (Soil Moisture)	Total column soil moisture at the end of the month	mm	Soil properties influence nutrient availability and plant growth
srad (Downward Surface Shortwave Radiation)	Monthly total solar radiation reaching the Earth's surface, essential for photosynthesis	W/m^2	Directly impacts energy available for plant processes; changes in radiation affect vegetation growth
tmmn (Min Temperature)	Average minimum temperature for the month	°C	Temperature influences various aspects of plant metabolism and growth
tmmx (Max Temperature)	Average maximum temperature for the month	°C	Higher temperatures can influence plant physiology and growth
vap (Vapor Pressure)	Average vapour pressure for the month, related to humidity	kPa	Influences plant transpiration; reflects atmospheric moisture conditions
vpd (Vapor Pressure Deficit)	Average vapour pressure deficit for the month	kPa	Reflects atmospheric drying conditions; affects plant water loss
vs (Wind-speed at 10m)	Average wind speed for the month	m/s	Influences various ecological processes, including seed dispersal and plant responses to mechanical stress

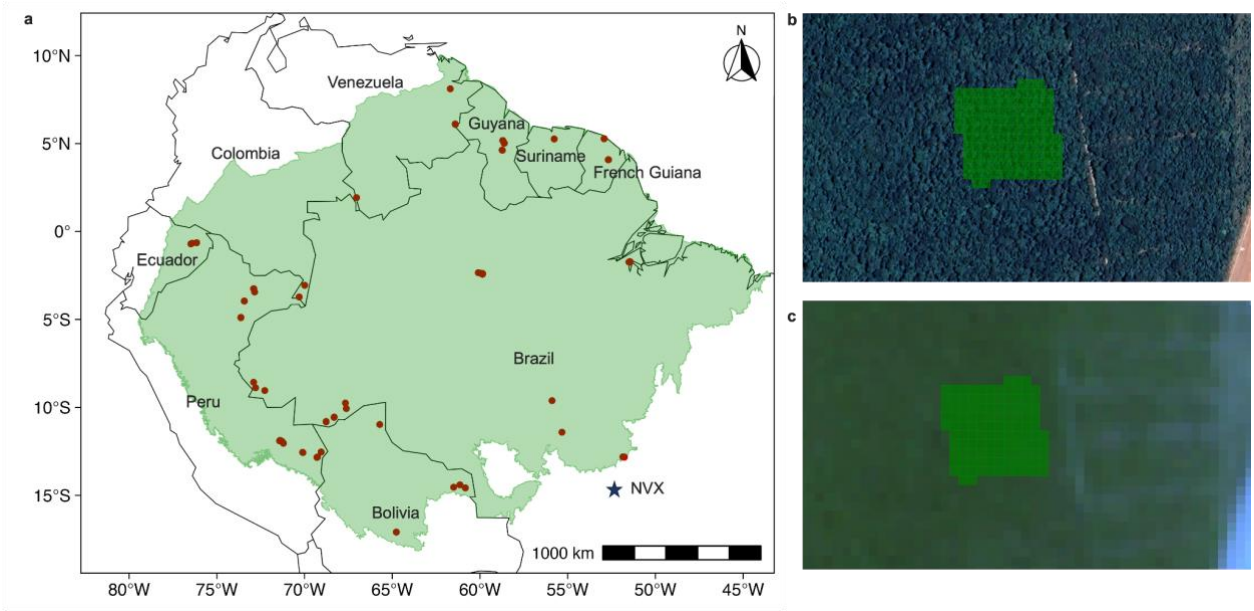


Fig. S1 | Location of the study sites and overlap of the subplots with the satellite pixels. **a,** Nova Xavantina plots (star), in a Cerrado-Amazon transition region in Brazil, and the Amazon vegetation sites (dots), spanning nine countries. **b,** the Nova Xavantina 'subplots' of 10 x 10 m, which were the unit used to calculate the trait community weighted mean based on the crown area of the trees in that pixel; and **c**, pixels of the Copernicus Sentinel-2 satellite showing the geospatial matching with the forest subplots.

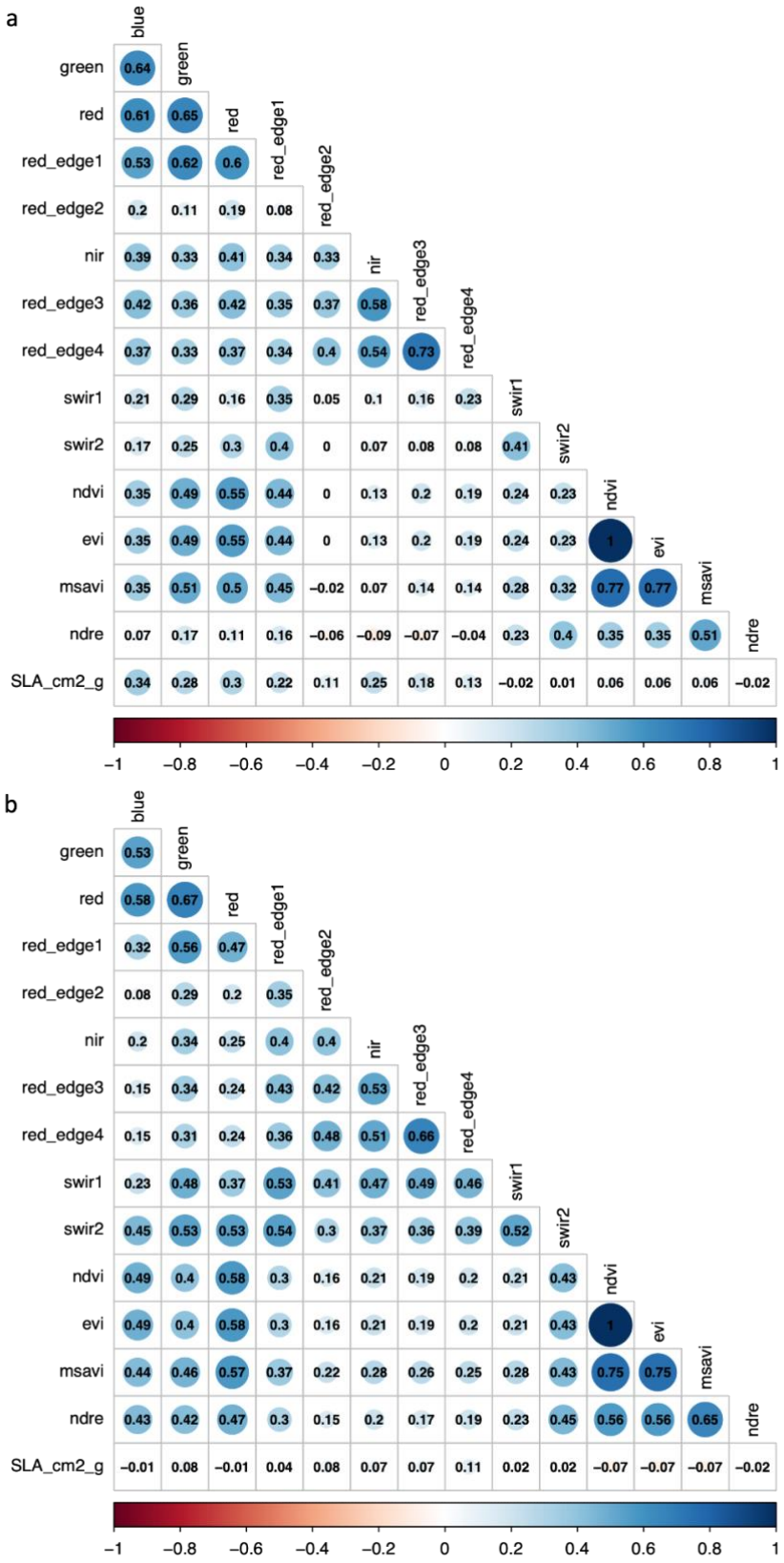


Fig. S2 | Pearson Correlation coefficients among the trait and reflectance variables in Nova Xavantina, Brazil during the (a) dry and (b) wet seasons. Reflectance variables are the intra-month coefficients of variation (%) over the year 2019. Asat = photosynthetic capacity at light saturated carbon assimilation rates (μmol m^{-2} s^{-1}); Amax: photosynthetic capacity at maximum carbon assimilation rates (μmol m^{-2} s^{-1}).

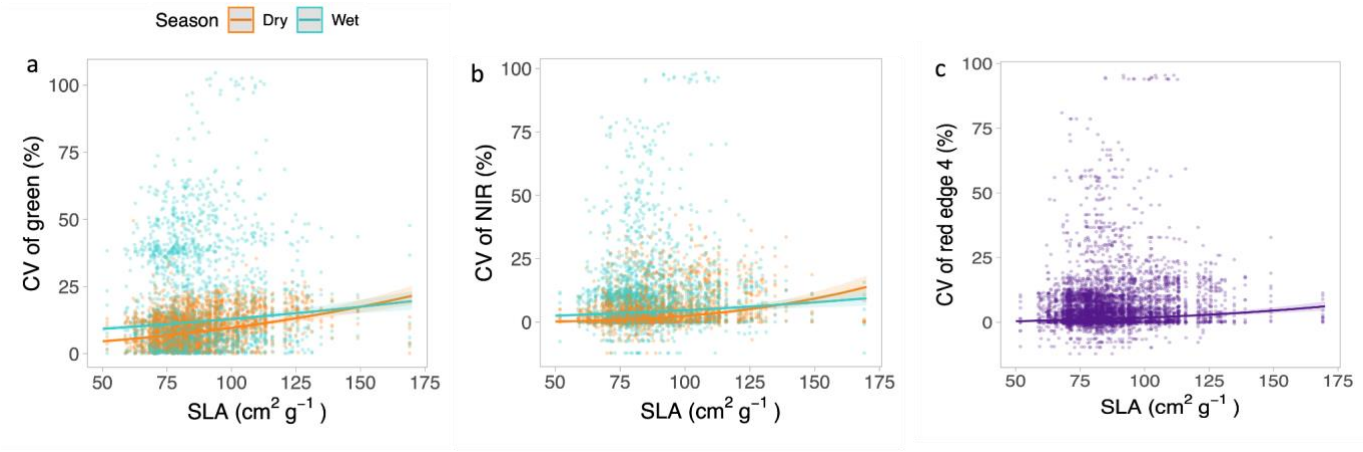


Fig. S3 | Conditional effects of Specific Leaf Area (SLA, in cm^2 per g) on the intra-month variation in reflectance (CV: Coefficient of Variation in %) of the (a) green and (b) NIR wavelengths across different seasons, and (c) red edge 4 band regardless of the season in Nova Xavantina, MT, Brazil. Each line represents the fitted values of a linear mixed-effects model.

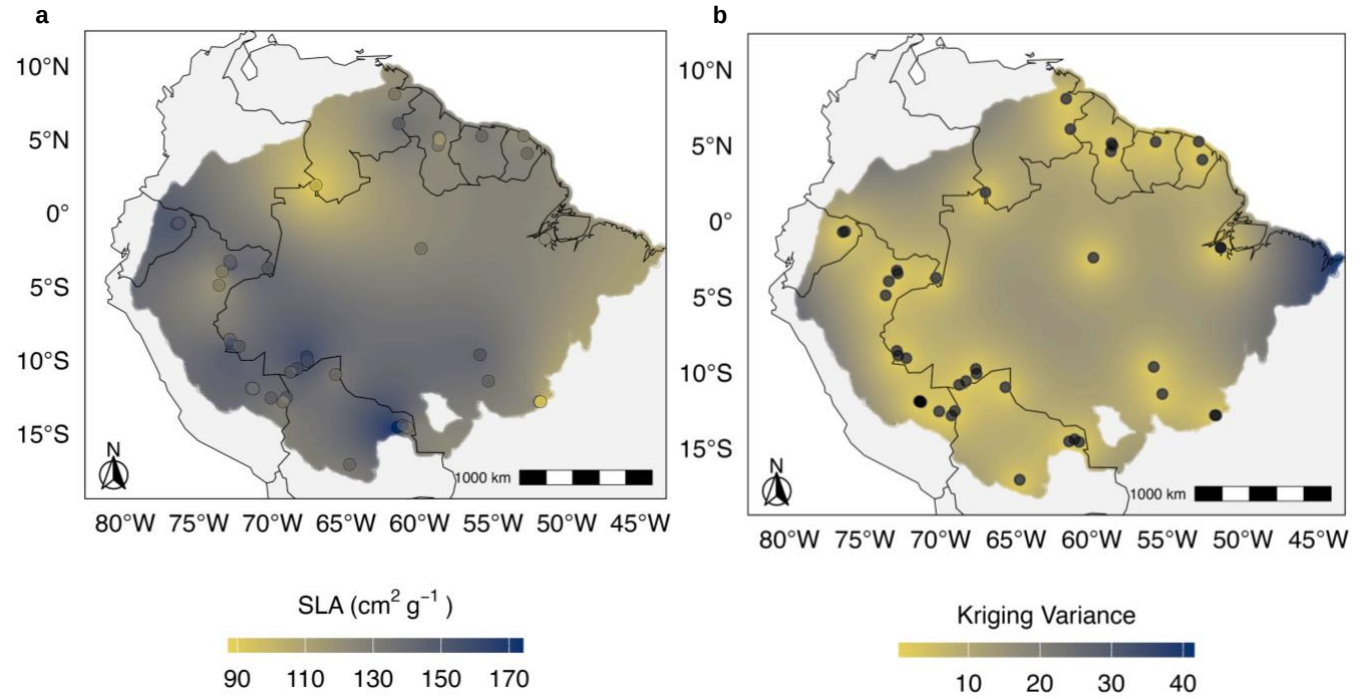


Fig. S4 | Specific Leaf Area (SLA) for regions of the Amazon biome. a, average Community-Weighted Mean of SLA (colour) for each study region (point) and predictions for the whole biome generated using interpolation by Ordinary Kriging. **b,** study regions (points) and uncertainty level of interpolated predictions.

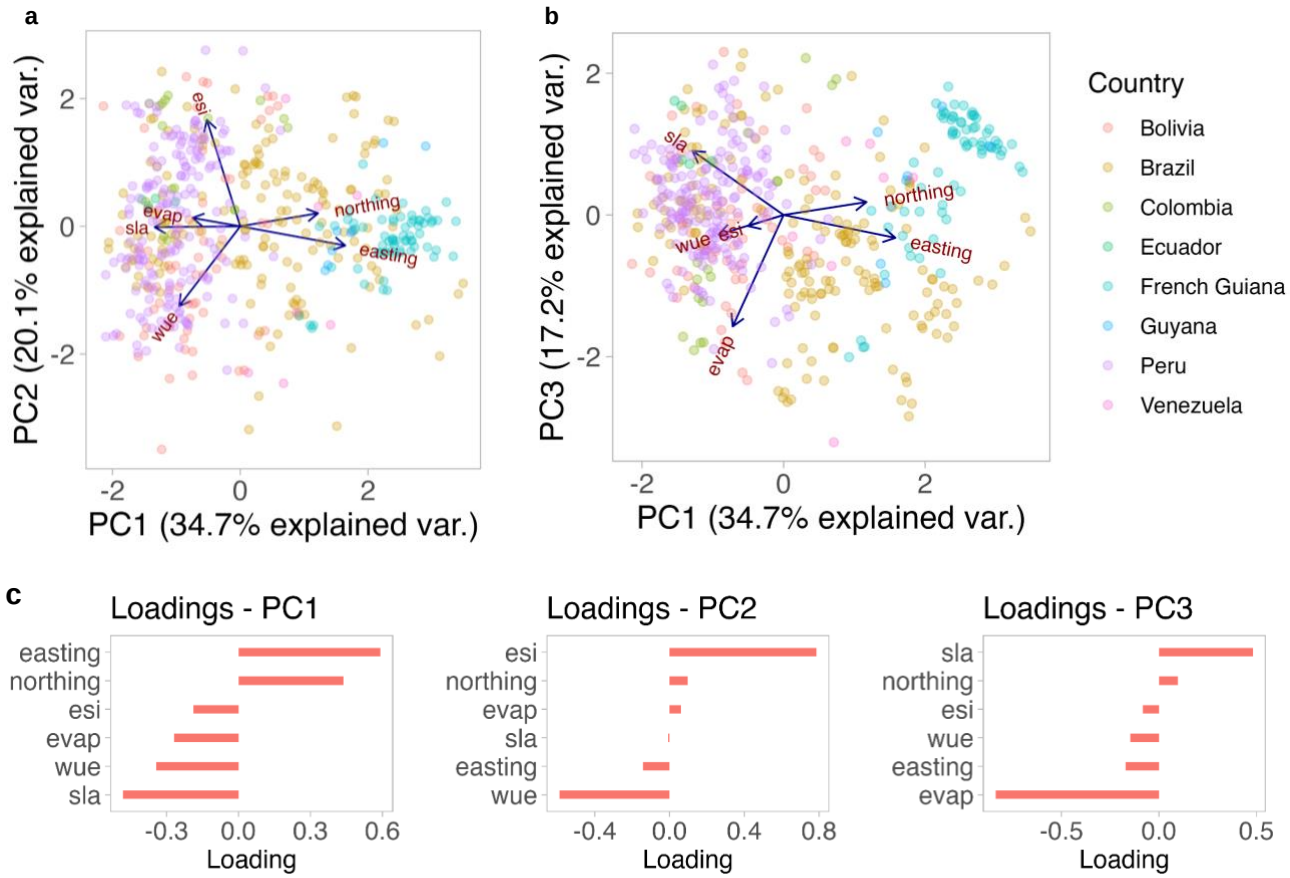


Fig. S5 | First and second (a) and first and third (b) axis, and loadings (c) of a Principal Component Analysis (PCA) calculated on normalised variables for Amazon sites. SLA = Specific Leaf Area; WUE = Water Use Efficiency; ESI = Evaporative Stress Index (high values mean low stress); Evap = Evapotranspiration; easting = Longitudinal degrees; and northing = Latitudinal degrees. Hydraulic variables are the month means over the years 2019-2022.

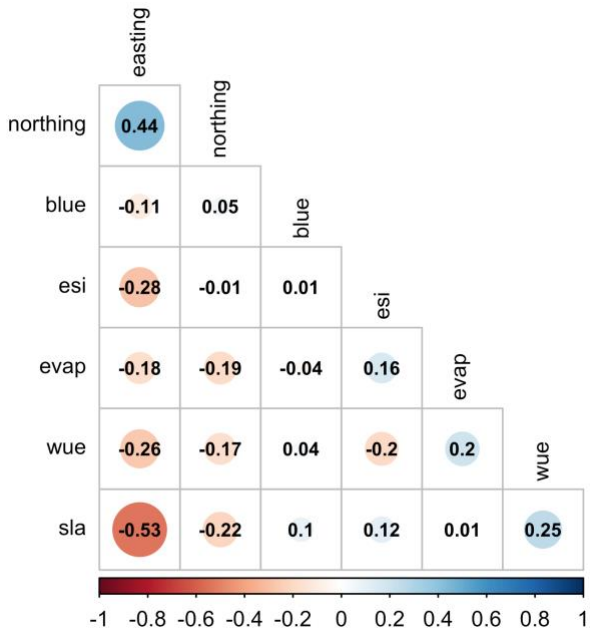


Fig. S6 | Pearson Correlation coefficients between SLA, spectral, and hydraulic variables in 130 Amazon sites. SLA= Specific Leaf Area; WUE = Water Use Efficiency; ESI = Evaporative Stress Index; Evap = Evapotranspiration; Easting = Longitudinal degrees; and Northing = Latitudinal degrees; blue = intra-month coefficient of variation (CV in %) for the year 2019. Hydraulic variables are the month means across the years 2019-2022.

Fig. S7 | Predicted Yearly Trends in the Coefficient of Variation (CV in %) of reflectance at the blue wavelength by season and regions of the Amazon biome. Each dot represents a data point for a particular plot in the Amazon Forest. The lines and shaded areas depict the model-predicted values and their confidence intervals, respectively. Predictions and intervals have not been back-transformed and are presented in square root scale.

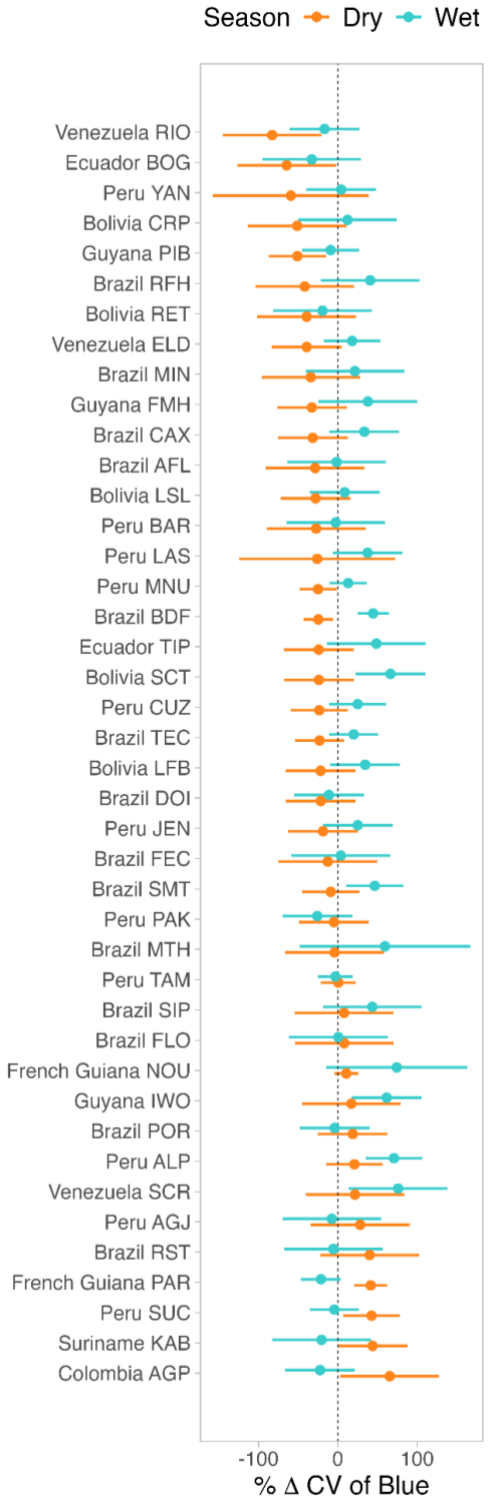


Fig. S8 | Predicted per cent change in the within-season variation of the blue reflectance (% Δ CV of Blue) between the periods 1984-1993 and 2013-2022 by season and region of the Amazon biome. Each point and line represent a model-predicted value and their confidence intervals, respectively.

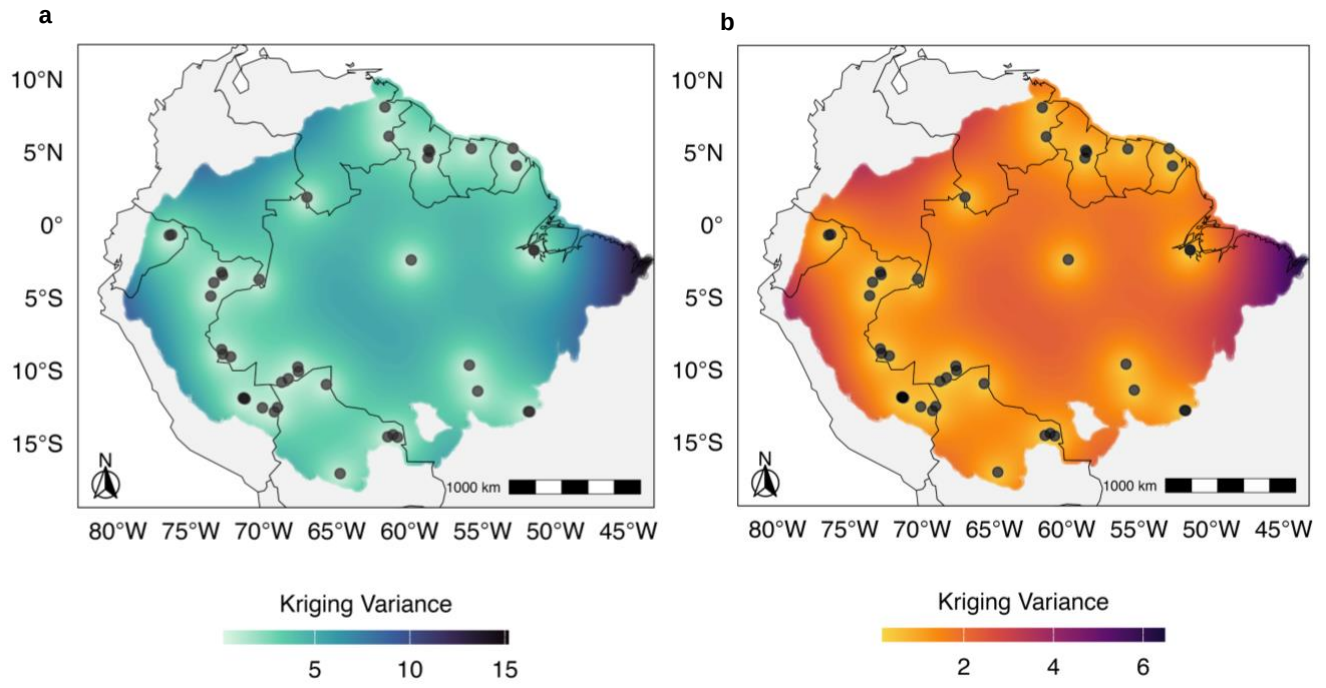


Fig. S9 | Uncertainty levels of interpolated predictions using Ordinary Kriging. **a,** uncertainty around the predictions of per cent change in the dry season variation of the blue reflectance (% Δ CV of Blue) between the periods 1984-1993 and 2013-2022 across regions of the Amazon biome (See Fig. 4 for the actual predictions). **b,** uncertainty around the predictions of change in climatic conditions (Δ Climate stress) between the periods 1984-1993 and 2013-2022 in the Amazon biome (See Fig. 5 for the actual predictions). Points represent the study regions, with colours representing the Kriging variance.

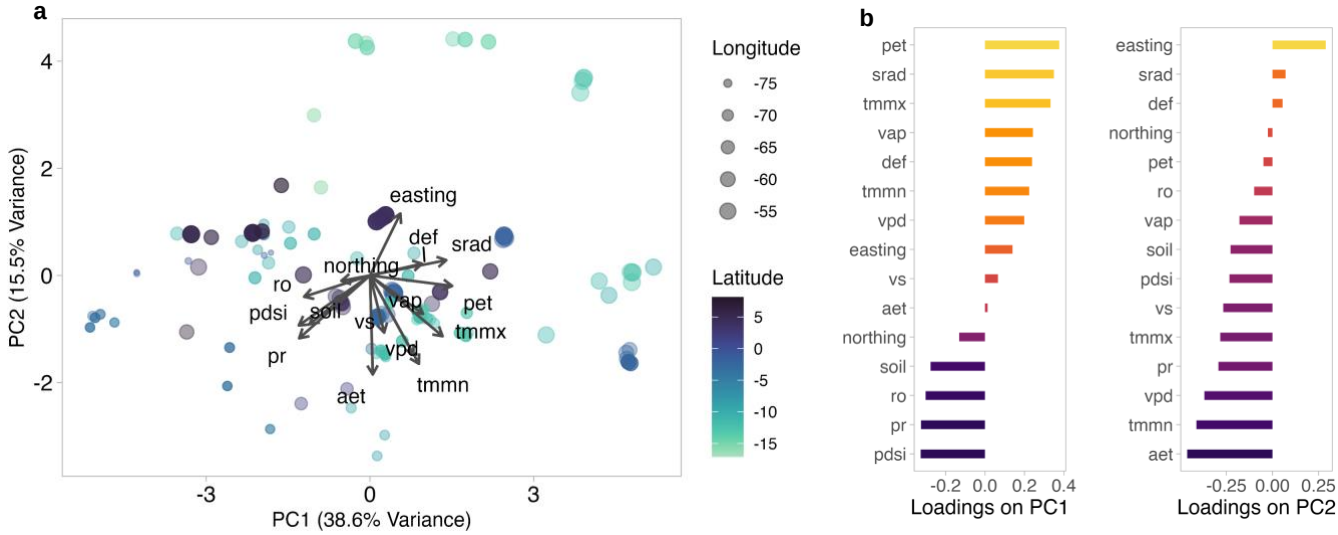
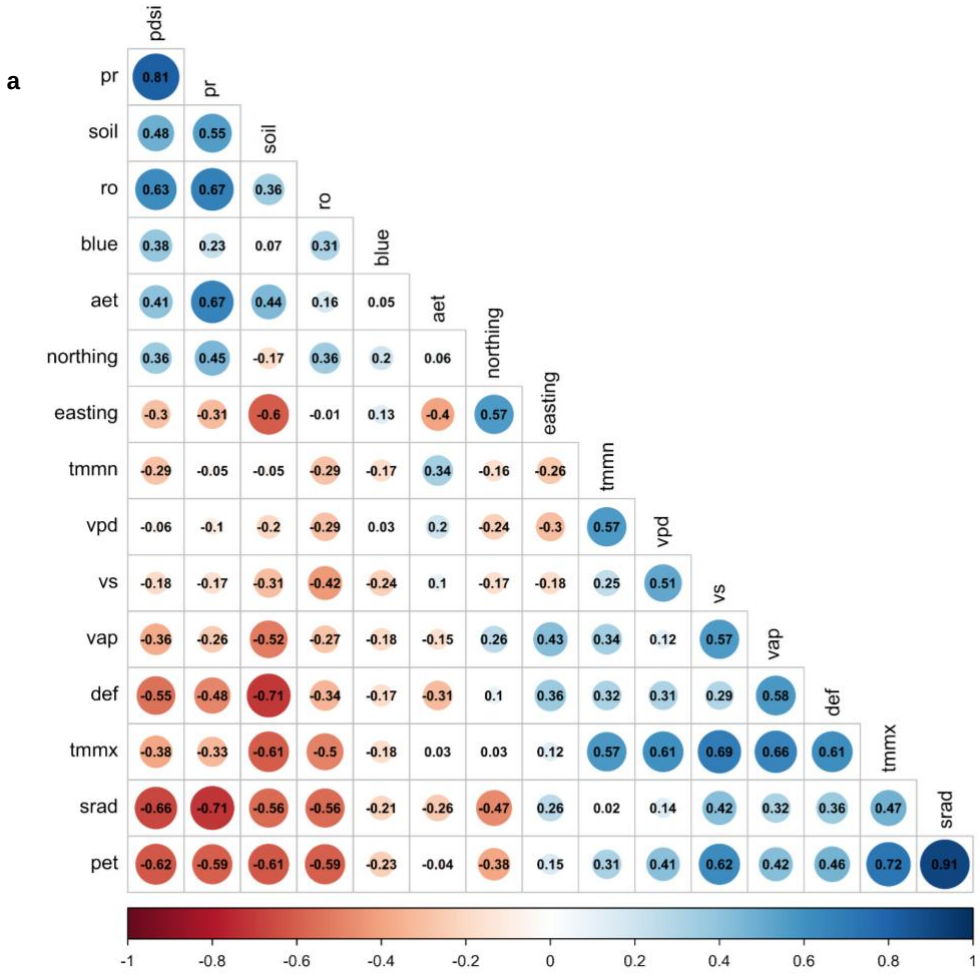


Fig. S10 | Principal Component Analysis (PCA) of changes in climatic and hydrological factors between the periods 1984-1993 and 2013-2022 in the Amazon biome. a, First and second axes of a Principal Component Analysis (PCA) on the per cent change (%Δ) of climatic and hydrological factors for the Amazon sites. Each point

represents a site in the Amazon biome, colour-coded by latitude and size-coded by longitude. **b**, loadings of PC1 and PC2 of each climatic and hydraulic variable from TerraClimate, which are their per cent variation in the annual mean between the periods 1984-1993 and 2013-2022 (See Table S3 for variable descriptions). aet = Actual Evapotranspiration; def = Climate Water Deficit; PDSI = Palmer Drought Severity Index; pet = Potential Evapotranspiration; pr = Precipitation; ro = Runoff; soil = Soil Moisture; srad = Downward Surface Shortwave Radiation; tmmn = Min Temperature; tmmx = Max Temperature; vap = Vapor Pressure; vpd = Vapor Pressure Deficit; vs = Wind-speed at 10m; easting = Longitudinal degrees; northing = Latitudinal degrees.



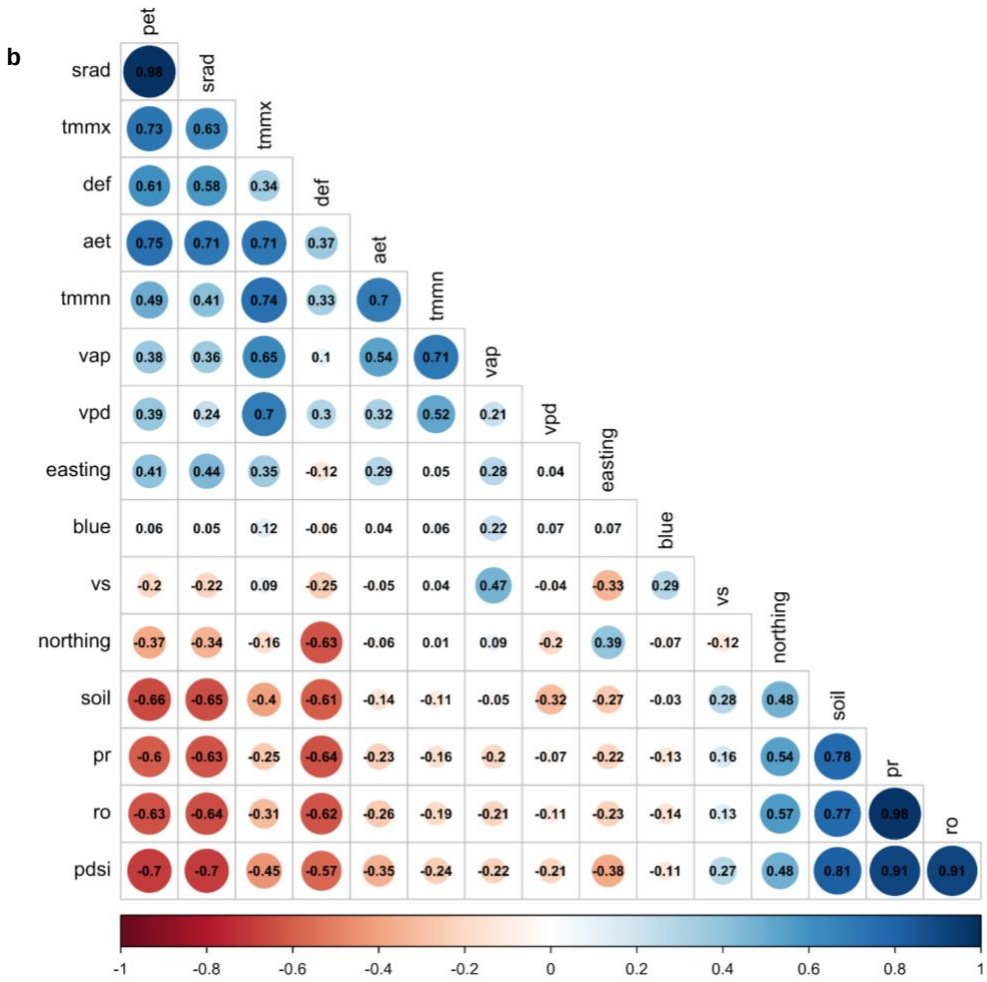


Fig. S11 | Pearson Correlation coefficients between the delta variation in the season mean of spectral, climatic, and hydraulic variables between the periods 1984-1993 and 2013-2022 in Amazon sites, during the (a) dry and (b) wet seasons. aet = Actual Evapotranspiration; def = Climate Water Deficit; PDSI = Palmer Drought Severity Index; pet = Potential Evapotranspiration; pr = Precipitation; ro = Runoff; soil = Soil Moisture; srad = Downward Surface Shortwave Radiation; tmmn = Min Temperature; tmmx = Max Temperature; vap = Vapor Pressure; vpd = Vapor Pressure Deficit; vs = Wind-speed at 10m; easting = Longitudinal degrees; northing = Latitudinal degrees. See Table S2 for variable descriptions.